Conditions and Trends
on

PONDEROSA PINE RANGES

IN COLORADO

By

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INTRODUCTION

The objective of this discussion is to present simple guides for judging range conditions and trends on ponderosa pine ranges in Colorado. It is designed for use by range managers, forest rangers, ranchers, and other individuals who may be interested particularly in administration of grazing lands within this vegetation zone. Comments and criticism designed to improve the methods described will be welcomed.

The discussion consists of three principal parts: (1) a brief description of the ponderosa pine type, (2) an outline of the steps to be followed in judging range conditions and trends; and (3) a list of criteria and characteristics to be used in recognizing range conditions and trends in the different vegetation stages that occur in the type in Colorado.

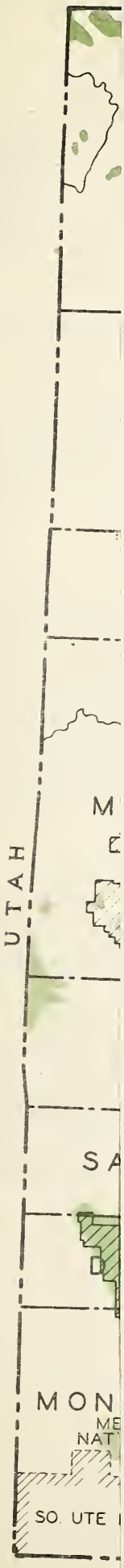
The standards and criteria discussed in the following pages apply only to the ponderosa pine zone and specifically to cattle ranges. While some of them will undoubtedly apply to cattle ranges in other zones, they should be used with caution under such circumstances. It is evident that entirely different criteria will be required on many sheep ranges.

THE PONDEROSA PINE TYPE

The ponderosa pine type covers approximately 4 million acres in Colorado, if both publicly and privately-owned lands are considered (See Map). It is highly important in the economy of the State in that it is a source of valuable timber, it includes much of the forage used by deer and elk during the critical winter season, and it furnishes a very considerable amount of livestock range, principally for cattle, during the summer season.

Ponderosa pine grows from an elevation of about 6,000 feet in the foothills to about 8,500 feet in the northern and 9500 feet in the southern part of the State. Characteristically, it grows on the ridges and south and east slopes. North slopes are usually covered with Douglasfir.

The ponderosa pine zone includes three aspects which are of special interest to the grazier: the savannah or open stand of timber where sunlight enters and an extensive herbaceous understory develops on the forest floor; the open grass parks which are devoid of trees; and meadows and streambanks; a fourth aspect, the closed forest which may be a pure stand of ponderosa pine, or at higher elevations and on north slopes a mixture of ponderosa pine and Douglas fir, is frequently so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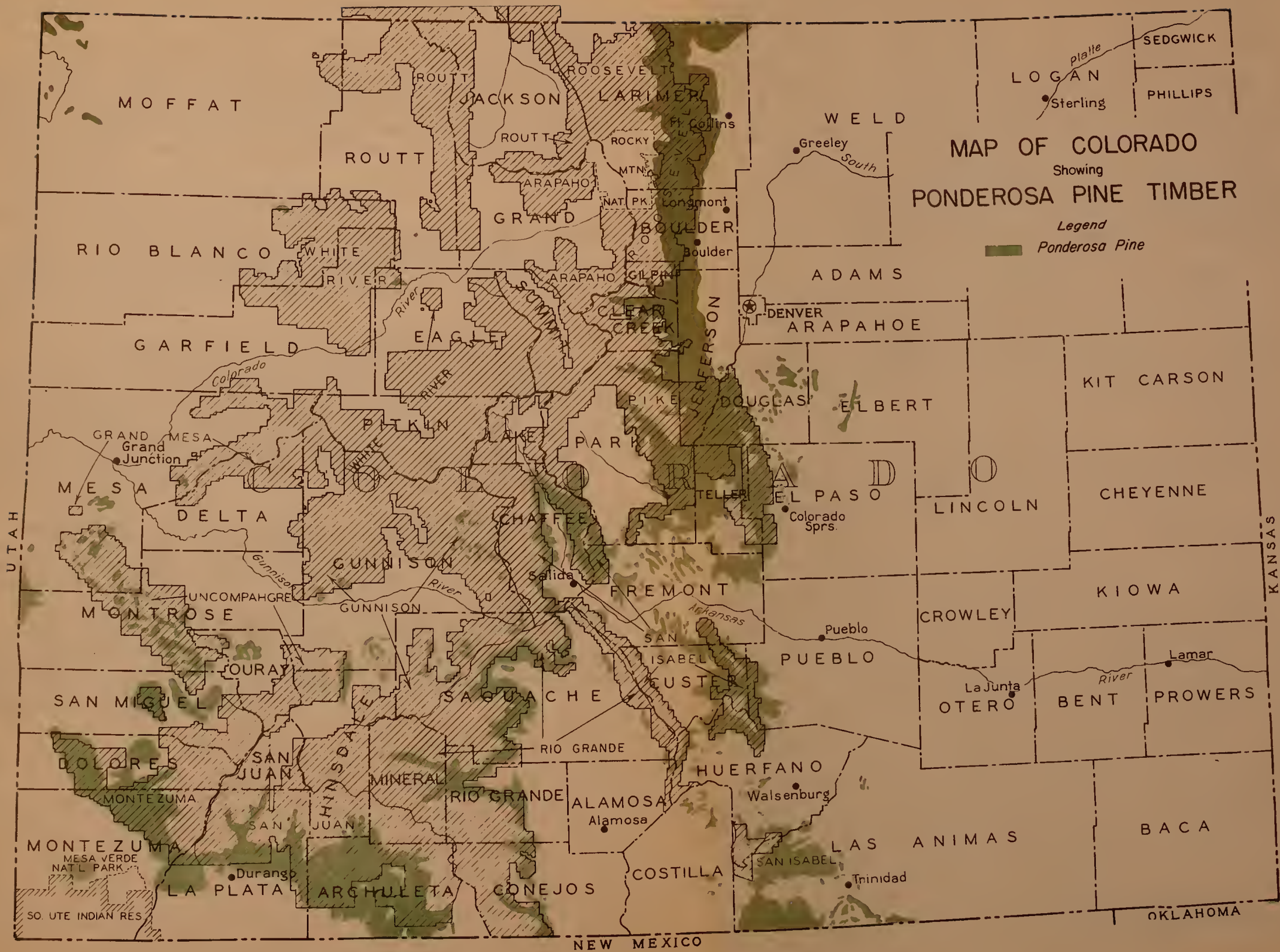

MAP OF COLORADO
Showing
PONDEROSA PINE TIMBER
Legend
Ponderosa Pine
MOFFAT
ROUTT
JACKSON
ROOSEVELT
LARIMER
WELD
LOGAN
SEDGWICK
PHILLIPS
Platte
Sterling
Fort Collins
Greeley
South
ROCKY MTN NAT PK
ARAPAHO
GRAND
BOULDER
Longmont
Boulder
RIO BLANCO
WHITE RIVER
ADAMS
DENVER
ARAPAHO
GILPIN
CLEAR CREEK
JEFFERSON
GARFIELD
EAGLE
SUMMIT
Colorado
PITKIN
LAKE
PARK
PIKE
DOUGLAS
ELBERT
KIT CARSON
GRAND MESA
Grand Junction
MESA
DELTA
CHAFFEE
TELLER
EL PASO
Colorado Sprs.
LINCOLN
CHEYENNE
UTAH
KANSAS
GUNNISON
Gunnison
Salida
FREMONT
Arkansas
KIOWA
UNCOMPAHGRE
MONTROSE
CROWLEY
Pueblo
SAN ISABEL
PUEBLO
Lamar
OURAY
CUSTER
La Junta
OTERO
BENT
PROWERS
SAN MIGUEL
SAGUACHE
HINSDALE
RIO GRANDE
DOLORES
SAN JUAN
MINERAL
HUERFANO
MONTEZUMA
RIO GRANDE
ALAMOSA
Walsenburg
Alamosa
LAS ANIMAS
BACA
MESA VERDE NAT'L PARK
Durango
COSTILLA
SAN ISABEL
Trinidad
LA PLATA
ARCHULETA
CONEJOS
SO. UTE INDIAN RES.
OKLAHOMA
NEW MEXICO

dense that the herbaceous understory produces little forage and consequently is of small interest from the grazing viewpoint.

Many variations occur within the pine belt - a belt which frequently is difficult to define on the ground since occasionally the altitudinal range of pine is taken over by pinon and juniper or by mountain brush types. The pine stand is also often spotty, occurring as patches and islands in other types. Locally, along stream beds, the pines touch a diversity of plant communities which vary from grassy meadows through willow thickets to stands of broadleaved trees such as maples, alders, and cottonwoods.

Successional stages in the ponderosa pine zone

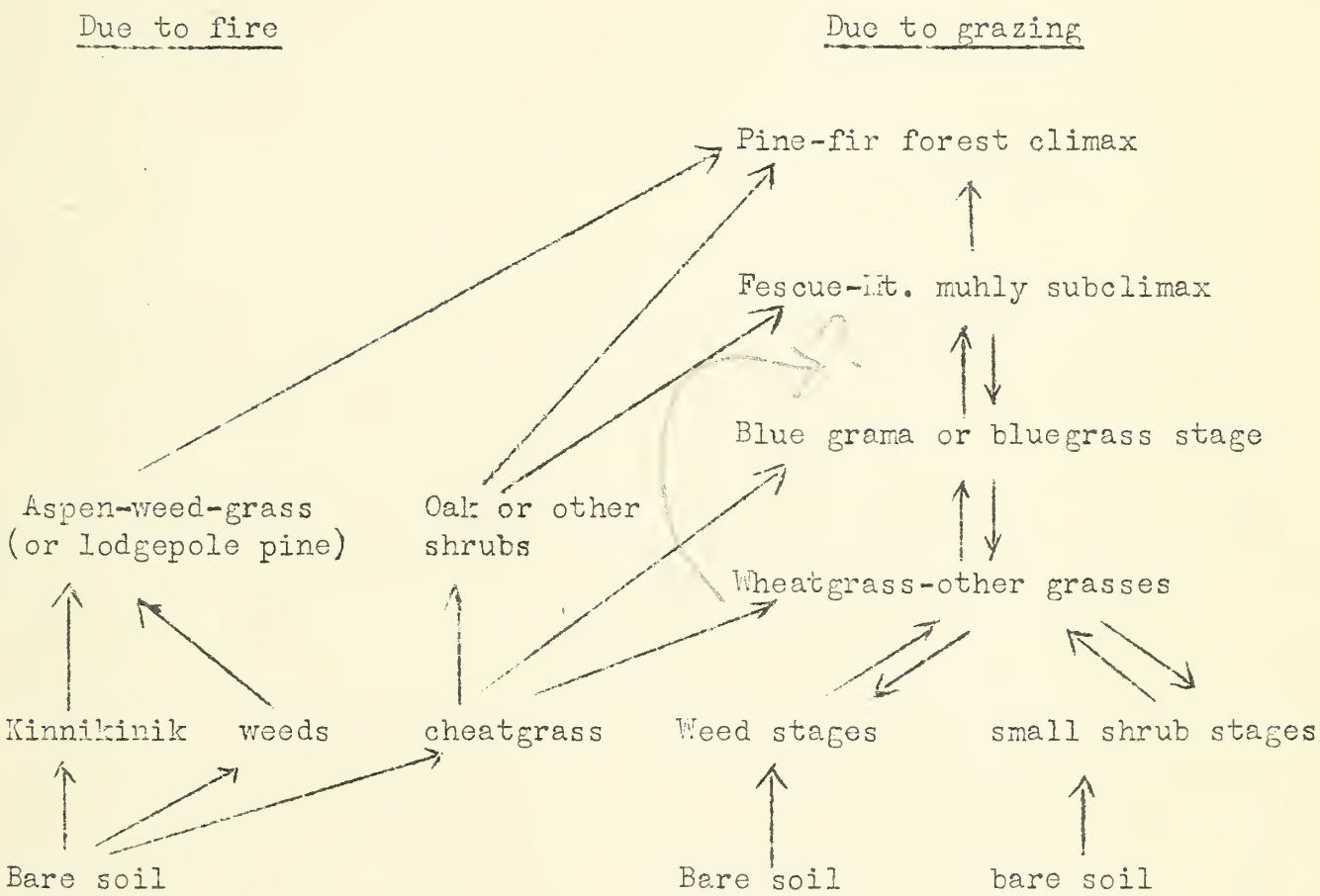
Each of the plant communities in the ponderosa pine zone represents a stage in succession or retrogression from a previous condition. Originally, the succession began on bare soil or rock. Without undue disturbance, the ultimate end of primary succession in this zone is climax pine or fir forest.

The range manager, however, is not so much concerned with these primary or ideal successions as he is with secondary or disturbed successions. What he sees on the ground is any one of a hundred or more plant communities of which the major characteristic, for example, is cheatgrass, Kentucky bluegrass, fringed sagebrush, blue grama, Arizona fescue, mountain muhly, bluestem wheatgrass, aspen, oak, or ring muhly. He is interested, from a practical viewpoint, in what each of these plant communities will give rise to under a changed system of management. He is interested in plant sequences, in upward and downward trends.

Ranges do not necessarily improve or deteriorate through the same series of stages that occur naturally in the absence of disturbances such as grazing and timber cutting. Likewise, improvement does not necessarily retrace the sequence followed in deterioration.

Some of the common trends resulting from grazing and fire are shown in diagram No. 1. To a certain extent these trends are followed downward as well as upward. The direction of the trend and the physical appearance of the successional stages, however, are greatly influenced by the rate of grazing, kind of livestock, season of use, type of soil, degree of erosion, and other factors.

Diagram No. 1 - Some common secondary successions in the ponderosa pine zone.



Plant succession in wet meadows follows a somewhat different pattern. Here, in the excellent condition, a highly restrictive hydrophytic or wet habitat exists. A few specialized species such as the sedges, rushes, buttercups and willows are able to keep out more poorly adapted competitors. Under grazing pressure, litter fails to accumulate, the vegetation cover is depleted, and the soil becomes dryer. Thus the site becomes favorable for large scale invasion by numerous species from surrounding areas. The trend from "excellent" through "good" to "fair" and "poor" is usually marked by a decrease in sedges, a temporary increase in grasses, and a striking increase in weed species. If erosion occurs, dry conditions may result and the trend is finally toward one or two very resistant species, most frequently the same species as occur on severely depleted upland ranges. The reappearance of meadow vegetation under an upward trend depends on the rapidity with which moisture conditions are restored. If moist conditions are restored quickly, as through beaver activities, the attainment of the sedge type of vegetation may be so rapid as to omit some of the intervening stages.

HOW TO JUDGE PONDEROSA PINE RANGES

Judging the range requires three steps: (1) identifying the vegetation stage; (2) ascertaining the range condition within the vegetation stage; and (3) detecting the trend within the condition class. Each of these steps must be taken in the order listed.

An understanding of objectives, and of certain criteria, is necessary before a good job of judging ranges can be done. Familiarity with these will aid in the establishment of uniformity of judgment between examiners.

Objectives

Range condition is generally visualized in terms of relative health. The term relative, therefore, implies a standard condition or optimum state of soil stability and vegetation development with which lesser degrees of range health may be compared and toward which they may ordinarily be advanced through good resource management.

In the ponderosa pine type, this standard is the bunchgrass vegetation, characteristic of grass parks and open tree stands, in which Arizona fescue (Idaho fescue in northern Colorado) and mountain muhly predominate but grow in combination with lesser amounts of other grasses and various weeds of medium to good palatability. This standard is characterized by high forage productivity and marked soil stability. If vegetation of this character is mismanaged, it degenerates to blue grama, bluegrasses, fringed sagebrush, weeds, or other plant communities marked by lower forage productivity, unstabilized soils, and increased runoff and erosion. If these lower stages are properly managed they tend to develop in the direction of a luxuriant bunchgrass community.

In meadows within the ponderosa pine type the standard is a continuous dense stand of sedges or meadow grasses growing in a deep moist soil with abundant litter on the surface and no gullies or accelerated erosion present.

The pine ranges and the meadows, however, are not all in excellent condition and most of them cannot be brought to that condition in a short time -- frequently not even in the life span of the average human being. A secondary or immediate objective is, therefore, necessary: the constant improvement of the range whatever its condition. If the condition is poor, improvement will make it fair. If it is fair, further improvement will make it good. Possibly that is all the progress one generation of men can make on some areas. The next generation can then carry on to make other fair ranges good and the good ones excellent.

Occasionally the range manager will encounter stages or condition classes which are below the optimum and where the indications point to naturally poor soil conditions rather than grazing as the cause. In such instances the criteria outlined in this handbook should be used and conditions and trends ascertained in the same manner as where they are the result of grazing use. Even though a given range is incapable of appreciable improvement, it should be rated in accordance with the principles outlined herein. The condition class can then be correlated with the recommended rate of stocking in order that a downward trend and a deteriorating condition will not be established. The vegetation and the soil should always be afforded every opportunity for improvement.

The Three Steps in Judging

Identifying the vegetation stage

The herbaceous and shrubby vegetation in the ponderosa pine zone includes the following kinds of plant communities:

	See page
Bunchgrass	11
Short-grass	15
Mixed grass - weed	19
Half shrub-weed	22
Meadows	22
Browse communities	25

Ordinarily a given range can be placed in the proper one of these stages by visual inspection. General aspect and the composition as determined by the principal species are the only elements that need be examined in this first step. If, for example, Arizona fescue and mountain muhly provide the dominant aspect, then the range is characterized by a bunchgrass community. If blue grama, ring muhly, Kentucky bluegrass, or other sod-forming species provide the aspect, then the area should be classified as being in the short-grass stage. The descriptions of all the stages listed above should be read carefully so that the characteristics of each are clearly in mind.

Ascertaining the range condition

When the vegetation stage has been identified, the second step is to ascertain the range condition for the particular stage under consideration. Five major elements should be considered in making the decision: (1) composition of the forage cover, (2) vigor of the plants and of the forage stand, (3) density (as checked by the step-point method), (4) soil condition, and (5) status of erosion. These elements are set forth in the description of vegetation stages and condition classes beginning on page 9 . The range condition should be ascertained tentatively by considering the first three criteria: composition, vigor, and density. Then the discussion of soil and erosion indicators should be referred to for further evidence of the range condition. The final judgment should rest on consideration of all the elements observed.

Checking the trend

The indicators of upward trend and satisfactory management and downward trend and unsatisfactory management are listed beginning on page 26 . These deal with the plants, the soil, erosion, and use of forage by livestock. The determination of trend should be attempted only after the range condition has been judged.

Criteria used in judging range condition

The five elements listed above should be given major consideration in judging range condition in the ponderosa pine type. Some grazing investigators believe, however, that two additional elements should be considered: forage utilization and the weight and condition of animals using the range.

The cumulative effect of several years' use unquestionably is one of the major factors contributing to the present range condition. Cumulative effect of use, if it could be accurately measured, might be considered, but in too many instances this information is not available.

The weight and condition of animals using the range are more directly related to stocking rates, quality of animals, and previous feeding and treatment than they are to range condition. Our experimental evidence indicates that animals on a properly stocked range in fair condition, for example, do not differ greatly in weight and condition from similar animals on properly stocked ranges in good condition. This statement applies to ranges which still have palatable plants available for use and not to severely depleted ranges which should not be grazed at all.

Forage composition

The complete list of species for a plant community represents its floristic composition. Greatest attention should be given to the dominant and most abundant species. In general, composition provides the aspect

or general appearance which will in most instances allow the examiner to place a given range in its proper category at a glance. Thus, a stand of Arizona fescue and mountain muhly can be distinguished automatically from a stand of blue grama or one consisting of a mixture of pingue, fringed sagebrush, or weeds.

Plant vigor

In evaluating vigor, five separate elements or components should be considered: (1) height of seedstalks; (2) number of seedstalks per plant; (3) age classes of plants; (4) frequency or abundance, and size of plants, especially those with dead centers; and (5) the distance between plants.

Normally the grasses on good and excellent ranges will be larger and more thrifty in appearance than grasses on fair or poor ranges. As a rule the seedstalks are higher and more numerous on grasses which are found on ranges in the upper condition classes because the plants have not been stunted by excessive use.

The age classes refer to seedlings, young plants, mature plants and old plants. When all classes are present for a given species, the indication is that that species is "holding its own" on the range. When only one class is present, a trend is usually indicated, especially if the plants are mostly old and have dead centers. The distance between plants is an indicator of the vigor of the stand as a whole and is valuable in ascertaining range condition.

Step-point density

The densities used in this handbook are based on a simple procedure which has been referred to as the "step-point" method or as the "pace-transect." Estimates obtained by this method are not necessarily comparable with the square-foot method or the reconnaissance method, but they correlate reasonably well with these two methods.

The mechanics of the method are as follows: The examiner should make a "point" - a white or colored mark or notch - about 1/8 inch wide on the tip of either his right or left shoe sole. He should then select a course, preferably, but not always, a straight line, which will take him through an average or representative part of a selected type or plant community. He should take 100 paces, considered a transect, along this line. He can mentally count the paces, meanwhile recording "hits" by means of a tally register or by transferring a pebble from his right to his left hand at every hit. Where total grass density (including sedges) is desired, a hit consists in the point landing in a clump of live grass, just touching or covering an individual spear, clump, or small plant, or being screened by landing under live grass so that such grass is between the "point" and the examiner's eyes. A "miss" consists in the point landing on bare ground, dead grass or in live vegetation such as weeds, no one of which is recorded. If the examiner steps on a plant which is broken down and projects beyond the point but the point is beyond the normal position of the grass, it is considered a miss. Counting the number of

hits at the end of a 100-pace transect will give the grass density. The accuracy of the examination of a given area may, of course, be increased by taking more than one transect in a type. Ten transects are recommended in large type in order to insure a reasonable degree of accuracy. It is suggested that bending down to see if a hit has been made be avoided. The standards in this handbook were developed without stooping and hence comparisons in the field should be made without bending down or pausing more than momentarily.

The densities for the range conditions under each vegetation stage are listed under the various condition writeups below:

Soils

In evaluating soil as an indicator of range condition, two elements should always be given consideration. One of these is the amount of litter present on the soil surface. Litter includes both the partially decomposed and the undecomposed plant material. The other is the extent of organic soil or A horizon. In simple terms, this is the layer of soil which shows definite darkening as a result of the decomposition of plant and animal material. The details of how to use the above criteria are listed under the various condition writeups.

Erosion

In considering the extent and degree of erosion, the following elements should be evaluated: amount of bare soil, erosion pavement, soil deposition, perched plants, and gullies. Erosion is greatly influenced by the type of soil. Some soils may exhibit dense erosion pavements and accelerated surface removal without showing very extensive gullying.

Erosion pavement is the accumulation of small rock fragments on the soil surface. The density of the rock cover varies with the amount of soil removed through sheet and wind erosion and the abundance of rock fragments in the original undisturbed soil. In order to ascertain the relative density of the erosion pavement, the examiner should compare the amount of rock fragments on the surface with the amount in the soil immediately beneath.

Gullies are easily recognized, but at least one caution should be exercised in using them as indicators of range conditions. If gullies are present and considered as an element in determining condition they must have developed as a result of processes originating within the area. For example a gully occurring as a result of excessive runoff from a road or from an adjacent depleted area should not ordinarily be considered in the evaluation of condition for the area being examined. The presence of gullies, irrespective of their origin, however, may materially affect the trend of range condition in any given area.

The relative density of the erosion pavement, the nature of the gullies, the soil deposition, and related features characteristic of the range condition classes are listed in the condition writeups below.

VEGETATION STAGES AND CONDITION CLASSES

The discussion here lists the criteria for identifying the following vegetation stages and for judging range condition within these stages: bunchgrass, short-grass, mixed grass, half shrub-weed, and meadows. The pine-browse communities, sub-climax forest communities, and climax forest associations are briefly discussed but condition classes have not been formulated for the herbaceous stages in these communities. When these communities are encountered, their range condition should be judged by the nature of the herbaceous understory which will ordinarily fall into one of the vegetation stages listed in the first sentence of this paragraph.

Summary of Condition Class Criteria and Correlated Grazing Capacities on Ponderosa Pine Ranges

Condition Class Criteria

		Excellent	Good	Fair	Poor	Severely Depleted
Density Per. Grasses & Sedges	Bunchgrass	50% +	30-50%	20-30%	10-20%	10% -
	Mixed grass	"	30 +	"	"	"
	Short grass	-	40% +	30-40%	10-30%	"
	Half shrub	-	-	-	10% +	"
	Meadows	70% +	50-70%	30-50%	20-30%	20% -
Plant Vigor		Very high	High	Medium	Low	Very low
Litter	Grass stages	90%	75%	50%	50% or less	0%
	Meadows	100%	100%	75% +	"	"
Erosion		None	Slight	Moderate	Severe	Severe

Grazing Capacities

Condition Class	Excellent	Good	Fair	Poor	Depleted
	Acres per AUM	Acres per AUM	Acres per AUM	Acres per AUM	Acres per AUM
Degree of slope:					
Grass stages 0 - 20%	2 - 3	3 - 4	4 - 8	8 - 15	-
20 - 40%	3 - 4	4 - 6	6 - 12	-	-
40 - 60%	4 - 6	6 - 12	-	-	-
Meadows	½ - 1	1 - 3	3 - 5	5 - 8	-

Note: Degree of slope assumes the average or prevailing slope on that part of the range under consideration. Stocking figures for steep slopes (40-60%) must be used with care and allowance must be made for the extent to which cattle actually use these slopes on the range since this will vary with local conditions.

Bunchgrass stage

Bunchgrasses are the characteristic plants in all the condition classes in this stage. Other species are present in varying amounts, but the aspect is furnished by bunchgrasses. Degeneration of bunchgrass ranges follows in general, one of two courses. The major bunchgrasses remain as the range deteriorates but decrease in numbers and amounts as the condition changes from excellent through good, fair, and poor to severely depleted or unusable. Or the bunchgrasses are gradually replaced by short-grasses, resulting first in a mixture of the two growth forms, and later in loss of the bunchgrass aspect accompanied by change to a short-grass aspect. This transition may take place anywhere along the line of degeneration; for example, replacement of the bunchgrasses by short-grasses may not begin until the bunchgrass stage has deteriorated to poor condition. Recovery may be the reverse of the above process or the range may improve by a different route, i.e. through a series of mixed grass-weed communities. These mixed grass-weed communities are sometimes succeeded by a transitory short-grass stage or they sometimes give way directly to bunchgrasses, if the latter species are present in sufficient numbers to furnish a source of seed.

Excellent condition

This condition is characterized by a luxuriant growth of Arizona fescue and/or mountain muhly (Fig. 1.). Idaho fescue occurs instead of Arizona fescue in northern Colorado, particularly on the Roosevelt National Forest. The individual grass tufts are not easily distinguished from one another at the height of the growing season. The grass chumps are usually spaced 2 to 4 inches apart; the plants vary from 3 to 6 inches in diameter. The seedstalks of Arizona fescue average 20 to 30 inches in height; for mountain muhly 20 inches or more. Seedstalk production is abundant in normal growing seasons.

The step-point density of grasses and grasslike plants is 50% or more. Litter is abundant, covering 90% or more of the interspaces. Organic soil is well-defined and at least 4 inches deep. Accelerated erosion is not apparent; there is no deposition on the uphill side of plants. There are no perched or pedestalled plants. No gullies originate on the area.

A good mixture of other desirable grasses is usually present in the stand. These include Thurber fescue (at upper edge of ponderosa pine zone), timber danthonia, prairie junegrass, and little bluestem (the last especially at lower elevations). Grasses of minor importance are slender wheatgrass, bluestem wheatgrass, blue grama, sedges, and native grasses. Less desirable and inferior grasses, such as sleepygrass, slimstem muhly, pullup muhly, bottlebush, squirreltail, and false buffalograss are rare and inconspicuous.

Weeds which occur frequently are Fremont geranium, nickleaf milkvetch, American vetch, western yarrow, Lambert crazyweed, bigflower cinquefoil, asters, grounsels, bluebell, avens and eriogonum. Hairy

Fig. 1.--Bunchgrass range in excellent condition consisting of a mixture of mountain muhly, Arizona fescue, timber danthonia, little bluestem, other grasses, and weeds. The soil is covered with vegetation and litter. Accelerated erosion is not evident.

Fig. 2.--Bunchgrass range in good condition. Mountain muhly is predominant with lesser amounts of junegrass, pine dropseed, timber danthonia, and Arizona fescue. The grasses and willows in the bottom show moderate use.

goldaster, trailing fleabane, common dandelion, fringed sagebrush, and pingue are infrequent or rare.

Allowable grazing rates are as follows:

	Degree of slope	Acres per A.U.M.
Gentle:	Flat to 20%	2 - 3
Moderate:	20% to 40%	3 - 4
Steep:	40% to 60%	4 - 6

Good condition

The stand is characterized by a vigorous growth of Arizona fescue (Idaho fescue in northern Colorado) and/or mountain muhly (Fig. 2). The individual grass tufts are easily distinguished even at a distance. The grass tufts are usually spaced 4 to 10 inches apart and the plants vary from 2 to 5 inches in diameter. The seedstalks of Arizona fescue average 20 to 30 inches in height; for mountain muhly, 10 to 20 inches. Seedstalk production is fairly abundant in normal growing seasons.

The step-point density of grasses and grass-like plants varies from 30 to 50%.

Litter is moderately abundant, covering at least 75% of the area not occupied by plants. Organic soil is well-defined but is frequently exposed in small spots. A very light erosion pavement is occasionally found on exposed areas. Pedestalled plants are rare. Gullies originating on the area are rare or absent.

Other bunchgrasses, such as timber danthonia, little bluestem, and spikefescue are usually scarce. They usually occur in isolated groups and not in uniform mixture with the dominant bunchgrasses. Other grasses which occur sparingly are slender wheatgrass, blue grama, nodding brome, and sleepygrass. Inferior species such as slimstem, muhly, mountain muhly and pullup muhly at higher elevations and false buffalograss, bottlebush squirreltail, and ring muhly at lower elevations usually are present in small numbers.

A variety of weed species is generally present, with approximately equal proportions of moderately palatable species such as Fremont geranium and American vetch and low-value species such as pussytoes, Fendler sandwort, Fendler groundsel, eriogonum, hairy goldaster, and trailing fleabane.

If browse species are present, such palatable shrubs as mountain mahogany and wax current are the most frequent in occurrence. Fringed sagebrush is generally present in small amounts. In southern Colorado, pingue is occasionally present in small numbers.

Allowable grazing rates are as follows:

	Degree of Slope	Acres per A.U.M.
Gentle:	Flat to 20%	3 - 4
Moderate:	20% to 40%	4 - 6
Steep:	40% to 60%	6 - 12

Fair Condition

The aspect is derived from an open stand of Arizona fescue (Idaho fescue in northern Colorado) and/or mountain muhly (Fig. 3). Individual grass tufts are usually spaced 10 to 20 inches apart. Plants vary from 2 to 5 inches in diameter; the larger individuals frequently have dead centers. The seedstalks of Arizona fescue average 15 to 25 inches in height; for mountain muhly, 10 to 15 inches. As a rule only a few seed stalks are produced even in normal growing seasons. The step-point density of grasses and grass-like plants varies from 20 to 30%.

Litter is very light. At least 50% of the spaces between plants consist of bare ground. Organic soil is present in patches and is shallow where it does occur. A moderately dense erosion pavement is usually present on exposed area. Perched plants are generally evident on moderate and steep slopes, and rare on gentle slopes and level ground. Small gullies originating on the area are frequently present. Large gullies are occasionally present.

The composition or structure of the vegetation in the fair condition varies considerably from place to place and with the grazing use to which it has been subjected. One common phase or appearance is furnished by mountain muhly in almost pure stand. Patches of pussytoes are common in this aspect and are conspicuous when the grass is grazed down until it presents a turf appearance. Another phase is presented by Arizona fescue stands with fringed sagebrush occupying the intervening spaces. In some places, pingue, groundsels, slimstem muhly, pullup muhly, ring muhly, or even blue grama may take the place of the fringed sagebrush in the spaces between the bunchgrasses. A third phase is one in which Arizona fescue and mountain muhly, either alone or in mixture with one another constitute practically the entire herbaceous vegetation. The spaces between these grasses in some instances are thinly occupied by pine dropseed, or in other instances by a few scattered weeds of low value.

The weed population includes a preponderance of low-value species, such as lupines, penstemons, groundsels, mountain goldenpea, Fendler sandwort, American pasqueflower, and trailing fleabane. Moderately palatable species such as geranium and American vetch are generally infrequent in occurrence.

The poorer browse species are occasionally present. The most abundant of these are fringed sagebrush, Wrights sage brush (in S. W. Colorado), big sagebrush (in northern Colorado), broom snakeweed, rabbitbrush, and pingue.

Fig. 3.--Bunchgrass range in fair condition. Older age classes of Arizona fescue are predominant. Mountain muhly grows between the fescue clumps with the general appearance of a broken sod instead of a bunchgrass.

Fig. 4.--Bunchgrass range in poor condition. The Arizona fescue tufts are vigorous but widely scattered. The poor condition here is the result of shade as well as heavy grazing. Erosion is not excessive.

Allowable grazing rates are as follows:

	Degree of Slope	Acres per A.U.M.
Gentle:	Flat to 20%	4 to 8
Moderate:	20% to 40%	6 to 12
Steep	40% to 60%	Ordinarily no grazing

Poor condition

This condition is characterized by a sparse stand of bunchgrasses (Fig. 4). When the stand consists of Arizona fescue, the tufts are widely spaced (1 to 3 feet apart) and usually of small size. When the stand consists of mountain muhly, the tufts are generally small and scattered, giving the appearance of a bluegrass sward which has been broken up by trampling. Bare ground is a conspicuous feature. Seedstalks of grasses frequently are not produced. If present, those of Arizona fescue are 10 to 20 inches high; those of mountain muhly 10 to 15 inches high.

The step-point density of grasses and grass-like plants varies from 10 to 20%.

Litter is almost entirely absent. Organic soil is very shallow and is usually absent over much of the area. Sheet erosion is pronounced in most instances. A dense erosion pavement is common. Soil is deposited behind plants and obstructions on slopes and perched plants and exposed roots are characteristic. Gullies originating on the area are numerous and are all sizes from rills to ditches. They may be absent on level ground.

The vegetation in this condition class presents several phases. One phase is furnished by mountain muhly when it constitutes practically the only grass species in the stand and is grazed down until it has the appearance of a badly broken turf. Patches of pussytoes are sometimes conspicuous because of their size, numbers, and gray-green color. A second phase is presented by Arizona fescue stands with practically nothing but bare ground between the grass clumps. A variation of this is common in which the intervening spaces are occupied by fringed sagebrush, pingue, rabbitbrush, or combinations of these small shrubs. At higher elevations the intervening spaces are sometimes occupied by mat-forming grasses, particularly ring muhly and slimstem muhly in combination with various weeds and the shrubby species mentioned above. A third phase, consisting of mountain muhly or Arizona fescue or a combination of the two, has the spaces between plants either occupied by scattered grasses or weeds or covered by mats of pine needles. In the latter situation, the poor condition is designated on the basis of very low forage production and not on the basis of soil condition, presence of gullies, vigor of plants, or erosion.

In the lower portions of the ponderosa pine type cheatgrass, ring muhly, false buffalograss, bottlebrush squirreltail, and mat muhly are often very prominent in the bunchgrass poor condition class.

The weed population consists mainly of low value species such as Fendler groundsel, hairy goldaster, slimstem cinquefoil, Fendler sandwort, creeping fleabane, lupine and pussytoes. The poorer browse species such as pingue, rabbitbrush, and broom snakeweed are present in some localities and not in others. Fringed sagebrush is often very abundant. Wrights sagebrush is common on areas in poor condition in S. W. Colorado, while big sagebrush occurs on many poor ranges in northern Colorado.

Allowable grazing rates are as follows:

	Degree of slope	Acres per A.U.M.
Gentle:	Flat to 20%	8 to 15
Moderate:	20% to 40%	Ordinarily no grazing
Steep:	40% to 60%	" " "

Severely depleted condition

In this category are areas which have been severely abused so that grasses have been largely eliminated. Only remnants of the bunch-grasses remain to indicate former condition. The step-point density of grasses is less than 10%. Fringed sagebrush, broom snakeweed, pingue and other half shrubs frequently predominate. Hairy goldaster, or very short turf grasses such as ring muhly or slimstem muhly are sometimes present in sparse stands at higher elevations; cheatgrass is common in the foothills. Practically no litter is present. Little organic soil remains. Deep gullies are often common. However, there may be deep organic soil, no erosion, and a dense litter cover. In this latter situation the stand of vegetation is so light that grazing is impractical.

Unusable condition

Some ranges are unusable because of factors other than grazing. Bare rocky areas are an example. In such instances there may be little organic soil and practically no litter. Vegetation is frequently sparse. On unusable ranges under dense stands of trees, however, there may be deep organic soil, no erosion, and a dense litter cover. In this latter situation the stand of vegetation is so light that grazing is impractical.

Short-grass Stage

This stage is characterized by grasses which tend to form a sod. The sward or turf aspect is the distinguishing feature of this stage. Short-grass communities in the ponderosa pine zone arise through retrogression from bunchgrass communities and also through recovery from mixed grass-weed or other communities lower in the scale of secondary succession. Constant over-utilization of existing short-grass communities usually results in deterioration through progressive thinning of the short-grass cover rather than through invasion by mid-grasses, or other species of different growth form. In some instances, however, there is a gradual

transition to a half shrub or even to a weed stage. The upward trend on short-grass ranges is sometimes characterized by a temporary dominance of mid-grasses followed by gradual transition to a bunchgrass aspect. The transition from short-grass to bunchgrass may take place without intervening transitory stages if the latter species are present in sufficient numbers to furnish a source of seed.

An excellent condition class is not recognized for short-grass or sod-grass communities in the ponderosa pine zone. Short-grass communities in this zone represent a step below the highly productive and more or less permanent bunchgrass subclimax when it is in excellent condition. Short-grass communities are usually characterized by a certain amount of soil deterioration and erosion; in other words, they are unstable. They seldom produce an unbroken sod; if they are used conservatively, they are ultimately replaced by bunchgrasses. Dense stands of Kentucky bluegrass in moist situations sometimes approach the excellent condition. On such sites they should be judged by the criteria listed for meadows.

Good Condition

This condition is characterized by a broken but rather good sod of blue grama at lower elevations (Fig. 5) and Kentucky bluegrass, mat muhly, or slimstem muhly at higher elevations. The short-grass clumps are usually spaced two to five inches apart. Kentucky bluegrass tufts are spaced not more than two inches apart. The seedstalks of blue grama average 8 to 12 inches in height; for bluegrass, 12 - 15 inches. Seedstalks are produced in moderate abundance in normal growing seasons.

The step-point density of grasses and grass-like plants should be 40% or more.

Litter is moderately abundant, covering at least 75% of the area not occupied by plants. Organic soil is well-defined but is frequently exposed in spots not covered by vegetation. A light erosion pavement is occasionally found on exposed areas. Pedestalled plants are rare. Gullies originating on the area are rare or absent.

Other grasses commonly present in this condition class include bluestem wheatgrass, bottlebrush, squirreltail, green needlegrass, needleandthread, and prairie junegrass. Low growing sedges are nearly always intermingled with the sod-forming grasses. Remnants of bunchgrasses on deteriorating ranges, or young tufts on improving ranges are occasionally observed. These bunchgrasses, midgrasses and sedges, however, do not obscure the short-grass aspect.

Weeds are generally not abundant but the following are commonly present: hairy goldaster, horseweed fleabane, pussytoes, yellow owlclover, penstemons, western yarrow, Lewis flax, and Fendler sandwort.

The following browse species are commonly present: broom snakeweed, pingue, rabbitbrush, and cottonthorn horsebrush. They are scattered widely and do not obscure the shortgrass aspect.

Fig. 5.--Sodgrass range in good condition. Blue grama is principal grass; the clumps are spaced 3 to 5 inches apart. Bitterbrush is prominent on this area, making it an excellent deer range.

Fig. 6.--Sodgrass range in fair condition. Blue grama is predominant; the plants are spaced about 6 inches apart and the clumps themselves consist of small tufts. Mountain muhly is beginning to occupy the area.

Allowable grazing rates are as follows:

	Degree of Slope	Acres per A.U.M.
Gentle:	Flat to 20%	3 - 4
Moderate:	20% to 40%	4 - 6
Steep:	40% to 60%	6 - 12

Fair Condition

Shortgrass ranges in this condition are characterized by an open sod (Fig. 6) and a thin cover of blue grama at lower elevations and Kentucky bluegrass, mat muhly, or slimstem muhly at higher elevations. Short-grass clumps or mats are spaced 6-12 inches apart. Bluegrass tufts are usually unevenly spaced 2 to 6 inches apart. The seedstalks of blue grama are 6 to 10 inches in height; those of Kentucky bluegrass 8 to 12 inches. Seed-stalks as a rule are not produced in abundance.

The step-point density of grasses and grass-like plants varies from 20 to 40%.

Litter is very light. Bare ground constitutes 50% or more of the area. Organic soil is present in patches and is shallow. A moderately dense erosion pavement is usually present on bare spots. Soil deposition is apparent behind obstacles on slopes. Perched or pedestalled plants are common on slopes, rare or absent on very gentle slopes and level ground. Rills and small gullies originating on the area are of frequent occurrence. Large gullies may be present.

Taller grasses in this condition class are usually scarce or absent. The following species are the most common: Bluestem wheatgrass, slender wheatgrass, needleandthread, green needlegrass, tumblegrass, sleepygrass, bottlebrush squirreltail, and green bristlegrass. On rocky sites, side-oats grama is found occasionally along with little bluestem which remains as a relict of a former better condition.

Weeds are generally scarce but the following are some times conspicuous because of their flower color or their growth form: rose pussytoes, Rocky Mountain pussytoes, milkvetches, hairy goldaster, stickseed (Lappula occidentalis), rush skeletonplant, silvery lupine, and Fendler groundsel. Saskatchewan cinquefoil and gland cinquefoil are sometimes locally abundant.

Fringed sagebrush is generally present in sufficient numbers to be conspicuous, although it does not obscure the shortgrass aspect. Other low growing shrubs which are some times numerous are pingue, snakeweed, rabbitbrush, and cottonthorn horsebrush. Arkansas rose and mamillaria are occasional in occurrence.

Allowable grazing rates are as follows:

Degree of slope		Acres per A.U.M.
Gentle:	Flat to 20%	4 - 8
Moderate:	20% to 40%	6 - 12
Steep:	40% to 60%	Ordinarily no grazing

Poor Condition

In this condition the shortgrasses grow in a thin stand with most of the ground surface visible (Fig. 7). Plants do not form a sod but consist of widely scattered tufts of blue grama at lower elevations and Kentucky bluegrass, mat muhly, or slimstem muhly at higher elevations. The bluegrass tufts are unevenly spaced 6 to 12 inches or more apart. The clumps or mats of other shortgrasses are spaced 1 to 3 feet apart. Seedstalks are few in number and in the absence of favorable growing conditions none is produced.

The step-point density of grasses and grass-like plants varies from 10 to 20%.

Litter is almost entirely absent. Bare soil frequently constitutes as much as 90% of the area not covered by living plants. Sheet and gully erosion are pronounced in many instances. Deposition of soil behind plants and other obstacles is very characteristic. The gullies, when present, frequently range in size from rills to ditches; they are nearly always present on slopes but may be absent on level ground.

Grasses other than those listed above are usually scarce. Those which are some times present include: Bluestem wheatgrass, slender wheatgrass, needleandthread, green needlegrass, sleepygrass, and green bristlegrass. Cheatgrass is frequently present at lower elevations. If it is sufficiently abundant to obscure the shortgrass aspect the condition should be classed as severely depleted.

Weeds are generally scarce and of low value.

Fringed sagebrush may be present in sufficient numbers to be conspicuous but not numerous enough to obscure the shortgrass aspect. The same criterion applies to the presence of pingue, broom snakeweed, rabbitbrush, cottonthorn horsebrush, and small soapweed.

Allowable grazing rates are as follows:

Degree of slope		Acres per A.U.M.
Gentle:	Flat to 20%	8 - 15
Moderate:	20% to 40%	Ordinarily no grazing
Steep:	40% to 60%	Ordinarily no grazing

Fig. 7.--Sodgrass range in poor condition. Kentucky bluegrass and prostrate knotweed are the principal species. The oaks in the background show a browse line and rabbitbrush is invading. The gully in the foreground did not originate on the area.

Fig. 8.--Mixed grass-weed range in fair condition. Common species in this stage are green needlegrass, slender wheatgrass, blue grama, western yarrow, and Fremont geranium. Bunchgrasses ultimately replace this class of vegetation under restricted grazing use.

Severely depleted and unusable condition

Only remnants of the short-grasses remain to indicate former condition. The step-point density of grasses is less than 10%. Low value weeds and shrubs such as hairy goldaster, broom snakeweed, and fringed sagebrush are common. The litter is gone and accelerated erosion is usually pronounced.

Mixed Grass-weed Stage

This stage consists of a mixture of weeds and grasses commonly found on ranges which are recovering from a former severely depleted condition. It is also found on abandoned fields. This stage characteristically follows the weed communities which develop in the initial phases of secondary succession. Neither the bunchgrasses or the short-grasses are important in this stage. Normally it is replaced by short-grasses after a few years and they in turn are ultimately replaced by the sub-climax bunchgrasses.

The mixed grass-weed stage is transitory and highly variable in composition. It sometimes produces more forage temporarily than the short-grass and bunchgrass stages which follow. This temporary abundance of forage, however, is of most benefit in the long run if a large part of it is left to form litter and organic matter, instead of being grazed heavily.

An excellent condition is not recognized for this stage. The vegetative cover is sometimes heavy, but it is not dependable as a source of forage year after year. Furthermore, the soil beneath this cover is seldom stabilized.

Good Condition

This condition is characterized by a good mixture of mid-grasses and tall grasses and often an abundance of weeds of medium to good palatability. The grasses are spaced 2 to 5 inches apart and at the height of the growing season sometimes give the appearance of a weedy field of small grain. The step-point density of grasses and grass-like species is 30% or more.

Litter is usually moderately abundant, especially if the area is not heavily grazed. Dead plants cover as much as 75% of the soil surface. Organic soil is present but not always well-defined. An erosion pavement often is present on bare spots. Pedestalled plants are rare or absent. New gullies originating on the area are rare or absent; old gullies which were originally active are usually covered with vegetation.

Grasses which are commonly present include bluestem wheatgrass, green needlegrass, slender wheatgrass, and various sedges. Blue grama, Arizona fescue, mountain muhly, prairie junegrass, and needleleaf sedge occasionally are present in small quantities. Increase in numbers of these species indicates a trend toward the short-grass stage or the ultimate bunchgrass aspect. Not infrequently the short-grass stage is

by-passed and the transition is directly to bunchgrass.

Weed species which are generally prominent include Fremont geranium, Fendler groundsel, western yarrow, and Lambert crazyweed. Shrubs which are sometimes present include rabbitbrush, big sagebrush, fringed sagebrush, and mountain mahogany. The aspect, however, is furnished by the grasses.

Allowable stocking rates are as follows:

	Degree of Slope	Acres per A.U.M.
Gentle:	Flat to 20%	3 - 4
Moderate:	20% to 40%	4 - 6
Steep:	40% to 60%	6 - 12

Fair Condition

This condition is characterized by an open and uneven stand of midgrasses and tall grasses (Fig. 8). The grass stand is sometimes "spotty," numerous areas being occupied by weeds with few grasses present. The grass aspect prevails, however, over the area as a whole. Occasionally areas are found in which a nearly pure stand of one species of midgrass or tall grass prevails. This kind of vegetation is likewise classified as fair if the other criteria, soil and erosion, correspond to the fair condition. In any event, the grasses are rather thinly spaced, being 6 to 12 inches apart.

Litter, consisting of dead and decaying plant remains, is very light. Bare soil generally constitutes 50% or more of the area not covered by vegetation. Organic soil is present in patches but is shallow where it does occur. Exposed mineral soil devoid of a covering of organic soil generally makes up a small proportion of the area. Erosion pavement is usually moderately dense where the soil is exposed. Soil deposition is apparent behind the larger plants and other obstructions. Perched plants are numerous on slopes, but infrequent on nearly level ground. A very few gullies may originate on the area. These are ordinarily small, although on some sites a few large gullies originating from roads or trails may occur.

The step-point density of grasses and grass-like plants varies from 20 to 30%.

Grasses most commonly present include bluestem wheatgrass, needlegrasses, sleepygrass, nodding brome, sand dropseed, and short-grasses. The weeds of most frequent occurrence are Fendler groundsel, western yarrow, trailing fleabane, showy goldeneye, and hairy goldaster.

Common shrubs are fringed sagebrush, pingue, broom snakeweed, and rabbitbrush. They do not obscure the grass aspect.

Allowable stocking rates are as follows:

	Degree of slope	Acres per A.U.M.
Gentle:	Flat to 20%	4 - 8
Moderate:	20% to 40%	6 - 12
Steep:	40% to 60%	Ordinarily no grazing

Poor Condition

The characteristic aspect in this condition is produced by a mixture of mid-grasses and tall grasses (Fig. 9) in which weeds are as conspicuous as the grasses. The grass stand is thin, the individual plants being spaced 1 to 3 feet apart. If stands of grasses are encountered with this spacing, and weeds are relatively scarce, the stands should still be classed as fair.

Litter is almost entirely absent. Organic soil is very shallow and may be absent over considerable areas. Both sheet and gully erosion are very pronounced as a rule and a dense erosion pavement is usually present. Soil deposition behind plants and obstructions on slopes, and perched plants and exposed roots are characteristic. Gullies originating on the area are numerous and may be all sizes from rills to ditches. Gullies may be absent on level ground.

The step-point density of grasses and grass-like plants varies from 10 to 20%.

The grasses most frequently encountered in this condition are bluestem wheatgrass, tumblegrass, sleepygrass, and occasional plants of blue grama and even mountain muhly. Cheatgrass is sometimes abundant at the lower elevations. It should not be included in the density estimate.

The common weeds include hairy goldaster, creeping fleabane, gland cinquefoil, prairie sunflower, stickseed, prostrate knotweed, Fendler groundsel, pussytoes, and others.

While any of the shrubs mentioned under the condition classes immediately above may be present, the two most constant species are fringed sagebrush and Arkansas rose.

Allowable stocking rates are as follows:

	Degree of slope	Acres per A.U.M.
Gentle:	Flat to 20%	8 - 15
Moderate:	20% to 40%	Ordinarily no grazing
Steep:	40% to 60%	" " "

Severely depleted and unusable condition

Only remnants of the mid and tall grasses remain if the condition has resulted from retrogression from a former mixed grass-weed stage. (Fig.10)

Fig. 9.--Mixed grass-weed range in poor condition. The ground cover includes sleepygrass, cheatgrass, fringed sagebrush and blue grama. Rabbitbrush and snakeweed are invading. The fire hazard is high.

Fig. 10.--Mixed grass-weed range in depleted condition. Ring muhly, fringed sagebrush, and various unpalatable weeds constitute most of the vegetation. A few mountain muhly and Arizona fescue tufts remain as relics of the former bunchgrass cover.

If the condition is developing from a denuded range (Fig. 16) or from an abandoned field (Fig. 17) in the direction of a mixed grass-weed stage some of the characteristic grasses of the vegetation to follow may be present but their step-point density is less than 10%.

Half Shrub-Weed Stage

This condition is characterized by semi-woody perennials of low stature such as fringed sagebrush, pingue, broom snakeweed, eriogonums, cottonthorn horsebrush, and goldenweeds. These plants commonly consist of a woody caudex from which herbaceous stems are produced that die back annually. Half shrubs are characteristic of abandoned fields, treeless parks, and open timber stands in the ponderosa pine zone which have been denuded of much of their original grass cover. Generally, a single species of shrub predominates, although occasionally several species occur in mixture. Grasses are usually present in small amount but the aspect is furnished by low shrubs. If the grass cover exceeds 10% by the step-point method and the soil and erosion conditions are susceptible to improvement under light stocking, grazing at the rate of 8 to 15 acres per animal unit on flat or gently sloping areas may be feasible in some instances. At any rate the range condition should be classed as poor and all stocking should be directed toward improvement of the grass cover and with no use of the shrubs.

Similar handling applies to the many ranges characterized by fringed sagebrush. Grazing animals will eat fringed sagebrush and maintain themselves in fair condition even on pure stands of this shrub because of its relatively high nutritive value. A nearly pure stand of fringed sagebrush, however, represents a severely depleted range condition and continued heavy use will ultimately result in complete loss of the soil through erosion, and consequently loss of all forage value as well. If grasses are present in sufficient amounts to enable one to classify the range as poor, the above-mentioned stocking rates may apply. But fringed sagebrush should not enter into the estimate of grazing capacity.

The following species, when they provide the type aspect and occur in nearly pure stands, most commonly denote a severely depleted condition: fringed sagebrush, cottonthorn horsebrush, pingue, rock goldenrod, broom snakeweed, rabbitbrush, hoarhound, lupine, trailing fleabane, pussytoes, hairy goldaster, Russianthistle, stickseed, cheatgrass, bottlebrush squirreltail.

Meadows and Streambanks

Throughout the pine zone, there are moist sites characterized by sedges, rushes, tufted hairgrass, redtop, bluejoint reedgrass, buttercups, iris, marshmarigold, and other moisture-enduring plants. Browse species, such as willows, dogwoods, alder, water birch, and bush cinquefoil are common. On somewhat drier sites and especially where the original cover has been disturbed, Kentucky bluegrass, white clover, and common dandelion are almost universally characteristic.

No sharp distinction can be made between meadows and parks, since the former gradually merge into the latter as soil moisture decreases. A decision can usually be made, however, on the basis of species present. If the plants are those characteristic of marshes and meadows the area should be placed in this category regardless of the wetness or dryness of the site at the moment.

The general surface of meadows is usually relatively flat and the easily erodible silt and peat are normally held in place by dense root mats, shrub clumps, and debris. Heavy use by livestock for a time generally results in minor soil and vegetation changes. Partly for this reason relatively small differences occur between meadows in the excellent and good condition classes. Once a channel is formed, drainage results in a very rapid loss of soil moisture and depletion may occur rapidly.

With drying out of the soil the characteristic species of the adjoining slopes usually invade the space originally occupied by meadow vegetation.

If dense clumps or stands of shrubs occur in meadows, allowance should be made for the space they occupy, i.e., shrub areas should be left out of the grazing capacity estimate.

Excellent condition

Meadows in excellent condition are characterized by a continuous dense stand of sedges, or a mixture of sedges and meadow grasses with relatively few weeds. The common grasses include bluejoint reedgrass, redtop, tufted hairgrass, timothy, and Kentucky bluegrass. Baltic rush is sometimes present in patches or as scattered clumps, but does not dominate the aspect.

Grasses and grass-like plants are uniformly spaced 1/2 to 1 inch apart and are at least 1 to 2 feet in height. The step-point density is 70% or more for grasses and sedges.

The litter is spongy and has a springy cushioned effect as one walks on it. The soil is usually a deep, porous layer of peat, coal-black or dark brown in appearance, or it may consist of a fine silt-loam where peat has not developed. Gullies, hummocks, and accelerated erosion are not evident.

The weeds which are usually present include small quantities of buttercups, pedicularis, and cinquefoils. Common dandelions and iris are rare or absent.

If shrubs are present, they grow in open stands, interrupted islands, or in clumps and stringers along streambanks. Their growth form is normal, not stubby or "hourglass" shaped.

Occasionally a situation is encountered where a meadow is dominated by a dense, vigorous stand of Kentucky bluegrass (Fig. 11). Because of

Fig. 11. --Meadow in excellent condition. The original vegetation has been replaced to a large extent by bluegrass but the ground cover, composition and value for grazing is such that it is classed excellent.

Fig. 12. --Meadow in good condition characterized by a mixture of sedges, wheatgrasses, bluegrass and clover. The willows do not show excessive browsing and Iris, dandelions and cinquefoil are not abundant.

the enduring quality of such a composition, its high palatability and resistance to grazing, it may be classed as being in excellent condition.

The more representative meadows and streambottom stringers, almost entirely composed of highly palatable sedges, grasses, and clovers with step-point densities of 70% or more, have an estimated allowable grazing rate of one-half to one acre per animal unit month.

Good Condition

Meadows in good condition have the same general appearance as meadows in excellent condition, but the step-point density is lower and more weeds are present. (Fig. 12). The common grasses include tufted hair grass, bluejoint reedgrass, redtop, Kentucky bluegrass, and occasionally bluestem wheatgrass. Various sedges are usually present.

Grasses and grass-like plants are spaced about 1 to 1½ inches apart and are 1 to 2 feet in height, but usually not uniform in height throughout the meadow. The step-point density of grasses and sedges varies from 50 to 70%. (Clover, if present, should be included with grass density).

Litter is matted and the soil is deep. Hummocks are sometimes found around bogs and springs. Cattle trails are not evident. No channel erosion originates within the area or at its margins.

Weeds, such as common dandelion, iris, cinquefoils, buttercups, and marshmarigolds are conspicuous in some meadows in good condition, but do not grow in dense colonies and do not dominate the aspect.

Bush cinquefoil, willows, bog birch, and similar shrubs are present in some situations, but do not grow in dense stands.

The step-point density of grasses and sedges (also including clover if the site is such as to support bluegrass and clover) averages between 50 and 70%.

The allowable grazing rate is one acre per cow month for the higher densities of grasses, sedges, and clovers and three acres for the lower densities.

Fair Condition

In this condition, meadows present a thin, patchy appearance owing to the presence of separate colonies of sedges, grasses, and weeds. The same sedges and grasses listed under the excellent and good conditions persist. Weeds such as iris, dandelion, cinquefoil, buttercups, and western yarrow are very prominent,(Fig. 13). Dense stands of willows, usually hedged by excessive browsing, and other shrubs are present in some meadows. Mats of Kentucky bluegrass and clover are also characteristic of certain meadows in this condition.

Fig. 13.--Meadow in fair condition, with dandelions, ushes, and Kentucky bluegrass predominating. The shrubby Cinquefoil and willows have not been excessively browsed. rizona fescue on hillside.

Fig. 14.--Meadow in poor condition. Willows and other shrubs have been eliminated. Due to trampling, site is becoming drier and weeds and fringed sage are replacing the native grasses and sedges.

Fig. 15.--Meadow in depleted condition. Dandelions furnish the principal cover which formerly consisted of Kentucky bluegrass. Remnants of shrubby cinquefoil remain in the background.

Fig. 16.--Weed-grass range in depleted condition. Scattered clumps of blue grama and mountain muhly are obscured by penstemons, groundsels (Senecio spp.), and fringed sagebrush. Sheet erosion is very evident.

The step-point density of grasses, sedges, and clover varies from 30 to 50%.

The litter is broken and the soil is exposed in places. In some instances the exposed soil is sandy or gravelly. In other instances loam is exposed. Hummocking is frequent. Along intermittant water courses there may be "jump-offs" or interrupted shallow channels or sod deterioration. Larger creeks show denuded banks, scouring, or gravel deposition, and some bank cutting.

The allowable grazing rate is three to five acres per animal unit month depending on the quantity of available forage.

Poor Condition

Meadows in poor condition have largely lost their meadow aspect and appear to be dominated by weeds, such as common dandelion, iris, pedicularis, marshmarigold, buttercups, western yarrow, or silver cinquefoil. Kentucky bluegrass, sedges, and timothy are frequently present, but in relatively small amounts (Fig. 14). Redtop is often present. On gravelly or dry loam sites mats of Kentucky bluegrass, white clover or mat muhly are common. Almost invariably the shrubs, if any are present, are damaged, dead, or partly dead with most of the remaining branches beyond the reach of livestock.

The step-point density of grasses, sedges, and clover ranges from 20 to 30%.

Litter is nearly absent. Large areas of soil are exposed. Gullies and channels are usually present. Creeks have barren undercut banks, scoured channels or sandbars.

The allowable grazing rate varies from five acres per animal unit month for the higher densities to eight acres for the lower densities.

Severely depleted meadows

In this condition the meadow aspect has been lost (Fig. 15). The "bottom has dropped out" and severe channeling, scouring, and cutting of banks has resulted in a lowered water table and drying out of the site. Invasion of plants from adjoining plant communities results in a short-grass, mixed grass, weed-shrub or other stage. When the meadow has thus been converted to a different stage, the standards applying to that stage should be used in judging range condition.

Browse Communities

Browse communities are found throughout the ponderosa pine zone. Most of these represent stages either in the natural succession or stages that follow fire (See diagram 1, p. 3). Ultimately, these stands would be succeeded by sub-climax grassland or by climax forest

Fig. 17.--Half-shrub range in depleted condition. Fringed sagebrush and snakeweed are practically the only remaining plants. The soil is bare and sheet erosion is pronounced whenever heavy rains occur.

Fig. 18.--Oak-ponderosa pine-bunchgrass range. The condition is only fair as indicated by the scattered stand of mountain muhly between the clumps of oaks. The condition is judged on the basis of the herbaceous vegetation, not the shrubs.

if not disturbed by repeated fires, timber cutting, overgrazing, or other artificial practices. The shrub communities encountered frequently include those characterized by oak, (Fig. 18), bearberry, manzanita, ceanothus, mixed shrubs (mixture of currant, gooseberry, bush rockspirea, serviceberry, rose, chokecherry, etc.), mountain mahogany, (Fig. 19), big sagebrush, (Fig. 20), aspen (Fig. 22), and bitterbrush (Fig. 21).

Where cattle use pine-browse ranges, the estimation of range condition and grazing capacity should be based on the herbaceous understory (the amount of grass present) and the standards for bunchgrass, short-grass, etc. stages should apply.

The impression should not be gained that browse is wholly undesirable. Many shrubs have a high protein content and are a nutritious part of the animal diet. They are generally harmed or eliminated from the range only after the grasses have been overutilized. Hence, it is believed that the safest procedure, until specific studies can be made of these browse communities, is to base grazing capacities on the grasses only as a means of preventing deterioration of the herbaceous vegetation and the soil. The livestock will naturally make some use of the shrubs anyhow.

JUDGING THE TREND OF RANGE CONDITION

Upward or downward trend of ponderosa pine ranges in general progresses either from one vegetation stage to another or from one condition class to another within the same stage. Thus the upward trend from a denuded range commonly proceeds through a mixed grass-weed stage, to short-grass, to bunchgrass. The downward trend frequently occurs in the reverse order. In some instances one or more of the intermediate stages is omitted. Deterioration or improvement also takes place within the stage itself. The downward trend wherein the stage remains as bunchgrass, for example, through all the steps from excellent, through good, fair, and poor, usually results from continued excessive overgrazing. The deterioration is so rapid that the bunchgrasses are thinned out but not replaced by plans common to lower vegetation stages.

All the plant sequences under different intensities of grazing, or different types of soil, and in different local environments cannot be described here. In fact, the systematic ecology has not been worked out in detail for a great many of them. In general, however, change toward the excellent condition as described for bunchgrass ranges and for meadows should be considered to be upward trend. Change away from these conditions should be considered to be downward trend.

Invasion of the climax trees in bunchgrass ranges is an indication that forage production and value will ultimately decrease. This kind of invasion, however, usually does not indicate a deterioration in site quality from the standpoint of soil loss or erosion hazard.

In ascertaining the trend the examiner should pay particular attention to indicators of change in composition, plant vigor, density, soil, and erosion. If a majority of indicators point to improvement, the trend should be judged as being upward; if a majority point to deterioration,

Fig. 19.--Mountain mahogany-little bluestem range in fair condition; the bluestem tufts are 6 to 12 inches apart. The shrubs are not included in the grazing capacity estimate for livestock but should be considered from the standpoint of forage for deer.

Fig. 20.--Big sagebrush-grass range in poor condition. The herbaceous species growing in a very thin stand are the basis for classifying this range in the mixed grass-weed stage and rating it as poor.

Fig. 21.--Bitterbrush-blue grama range in fair condition. The grass clumps are spaced 8 to 15 inches apart. From the standpoint of game animals this is good to excellent range.

Fig. 22.--Aspen-kinnikinnick type approximately 50 years after a fire. Mountain muhly, pine dropseed, timber danthonia, asters and western yarrow present. This area is still in depleted condition.

the trend should be judged as being downward. If they are about equal, the trend is neither definitely upward or downward. Upward trend usually indicates satisfactory management; downward trend indicates unsatisfactory management.

Indicators of Upward Trend

Vegetation

Increase in numbers and kinds of species characteristic of the better range condition classes; and decrease in numbers and kinds of species characteristic of the poorer range condition classes indicate upward trend. In the absence of permanent plots and yearly records this kind of change can be ascertained best by a study of age classes and plant vigor. If, for example, seedlings and young vigorous plants and mature plants of blue grama with seedstalks are all present in mixture with ring muhly plants, the majority of which are old and have dead centers, improvement in range condition is indicated.

Luxuriant growth of perennial grasses usually indicates improvement. High vigor is manifested by good seed production, relatively large size of individual plants, and healthy dark green color.

A variety of grass species present and reproducing generally indicates upward trend in contrast with situations where only a single species of grass is predominant.

Palatable species growing vigorously in places accessible to livestock and not differing greatly in vigor from plants of the same species growing in the protection of shrubs indicates at least that the range is not deteriorating.

Normal growth on old hedged surfaces of shrubs indicates improvement if the normal growth is not being currently removed by livestock.

The presence of annual weeds and poisonous species should be interpreted with caution. Annual weeds are frequently abundant in wet seasons either on improving or deteriorating ranges. Annual weeds also are likely to appear in abundance for one or two years on ranges which are improving following a reduction in stocking or other change in management. Poisonous plants frequently persist as relicts on improving ranges.

Soil and erosion

Litter that appears to be accumulating and that remains in place after moderate or heavy rainfall is an indicator of upward trend.

Rills and gullies with rounded sides and with vegetation on the sides as well as in the bottom indicate that vegetation is gaining control.

Erosion pavement and bare areas being invaded by plants and covered by litter indicate upward trend.

Pedestalled plants on improving ranges usually show evidence of producing litter which tends to cover roots that were formerly exposed.

Indicators of Downward Trend

Vegetation

Decrease in numbers and kinds of species characteristic of the better range condition classes; and increase in numbers and kinds of species characteristic of the poorer range condition classes indicate downward trend. In the absence of permanent plots and yearly records this kind of change can be ascertained best by a study of age classes and plant vigor. If, for example, seedlings, young vigorous plants, and mature plants of fringed sagebrush are all present in mixture with a stand of Arizona fescue consisting mainly of large tufts with dead centers, deterioration of the range is indicated.

Lack of vigor of perennial grasses usually indicates deterioration of the range. Lack of vigor is manifested by poor seed production, small stunted plants, and sometimes by pale green foliage and plant parts affected by fungus diseases.

Scarcity of all grasses except a single species indicates downward trend in contrast with situations where a variety of grass species are present and are actively reproducing themselves.

Palatable species growing vigorously in the protection of shrubs as contrasted with plants showing low vigor and absence of one or more age classes in places grazed by livestock generally indicate that the range is deteriorating.

Absence of normal growth on hedged surfaces of shrubs indicates downward trend, especially if some of the remaining stems and branches are still dying.

The presence of annual weeds, worthless species, and poisonous plants should be interpreted with caution. Annual weeds frequently are abundant in wet seasons on ranges which are going either upward or downward. If seedlings and young plants as well as mature plants of poisonous species are present the trend is probably downward.

Soil and erosion

Litter that is being lost or moved downhill during moderate or heavy rainfall is an indicator of downward trend. Deterioration of the range is also indicated when no litter is left to accumulate at the end of the grazing season.

Rills and gullies with straight or steeply sloping sides and with no vegetation or with only old plants on the sides and bottom are evidences of downward trend.

Soil and litter piled up behind plants and other obstructions after rainstorms indicate downward trend.

Erosion pavements and bare areas indicate range deterioration, especially if they are entirely devoid of seedlings and young perennial plants.

Pedestalled plants on deteriorating ranges usually produce little or no litter and the roots are frequently exposed.

Range Condition as Related to Big Game Requirements

The ponderosa pine type is important in wildlife management since it contains highly critical areas which are used as winter and spring range by deer, bighorn, and elk. These animals subsist very largely on the browse species and, therefore, usually do not greatly affect the grazing capacities determined for cattle.

The grazing capacity of game ranges is more nearly related to the amount of browse and to topographical and climatological factors than it is to quantity and quality of grass. In practically all pine ranges there are slopes on which the lower rates of stocking recommended in this report will result in much or all of the forage being left for game. Usually if cattle consume browse to the extent that there is serious competition with deer, the range is overstocked with cattle. On the other hand, there are instances where the amount of browse has been seriously reduced by deer and elk but where the grass cover has improved.

Browse counts or browse density estimates may be made on game ranges through the use of the step-point method previously described. Based on very limited studies the following standards are tentatively suggested:

Game Range Condition Classes

Condition		Browse density
Excellent	(Composition mainly preferred species)	30% or more
Good	" " " "	20% to 30%
Fair	" " " "	5% to 20%
Poor	" " " "	less than 5%

There is no true waste on game range except rockslides, cliffs or completely barren areas as under dense timber. The effect of slope is negligible. From the standpoint of soil and erosion the same principles apply as for cattle ranges.

RANGE CONDITION ON SHEEP RANGES

The kind of forage, the usually scattered watering places, and hot summer climate do not make the type well suited for sheep and there are relatively few places where ewes with lambs are normally summered on ponderosa pine range.

The objectives under sheep management should be the same as would be the case if cattle used the range. Range condition should be judged using the same criteria. However, a downward trend is usually first denoted by a lack of palatable weeds. Later the shorter and more succulent grasses and sedges disappear and browse may be damaged. Normally the succession is downward through the phases of the bunchgrass stage rather than through the shortgrass and half shrub-weed stages. Likewise, recovery is most frequently through succeeding condition classes in the bunchgrass stage.

Because palatable sheep forage is so easily eliminated it is generally advisable to stock pine ranges relatively lighter with sheep than with cattle, especially on predominantly grass ranges on gentle slopes. On such ranges a ratio of three to three and one-half ewes with lambs as equal to one animal unit should establish a reasonable stocking rate. In mixed brush types containing relatively more palatable sheep forage and on the steeper slopes sheep can make better use of the type and the normal ratio of four ewes with lambs equal one mature cow should be about right.

COMMON AND SCIENTIFIC NAMES

Grasses and Grass-like Plants

Common name	Scientific name
Arizona fescue	Festuca arizonica
Baltis rush	Juncus balticus
Bottlebrush squirreltail	Sitanion hystrix
Blue grama	Bouteloua gracilis
Bluegrass	Poa
Bluejoint reedgrass	Calamagrostis canadensis
Bluestem wheatgrass	Agropyron smithi
Cheatgrass	Bromus tectorum
False buffalograss	Munroa squarrosa
Green bristlegrass	Setaria viridis
Green needlegrass	Stipa viridula
Idaho fescue	Festuca idahoensis
Kentucky bluegrass	Poa pratensis
Letterman needlegrass	Stipa lettermani
Little bluestem	Andropogon scoparius
Mat muhly	Muhlenbergia squarrosa
Mountain muhly	Muhlenbergia montana
Needleandthread	Stipa comata
Needleleaf sedge	Carex eleocharis
Nodding brome	Bromus anomalus
Pine dropseed	Blepharoneuron tricholepis
Prairie junegrass	Koeleria cristata
Pullup muhly	Muhlenbergia filiformis
Redtop	Agrostis alba
Ring muhly	Muhlenbergia torreyi
Rush	Juncus
Sand dropseed	Sporobolus cryptandrus
Sedge	Carex
Sideoats grama	Bouteloua curtipendula
Sleepygrass	Stipa robusta
Slender wheatgrass	Agropyron trachycaulum (A. pauciflorum)
Slimstem muhly	Muhlenbergia filiculmis
Spikefescue	Hesperochloa kingi
Thurber fescue	Festuca therberi
Timber danthonia	Danthonia intermedia
Timothy	Phleum
Tufted hairgrass	Deschampsia caespitosa
Tumblegrass	Schedonnardus paniculatus

Common and Scientific Names

Common name	Scientific name
Weeds	
American pasqueflower	Anemone ludoviciana
American vetch	Vicia americana
Aster	Aster
Avens	Geum
Bigflower cinquefoil	Potentilla fissa
Bluebell	Campanula rotundifolia
Buttercup	Ranunculus
Cinquefoil	Potentilla
Common dandelion	Taraxacum officinale
Creeping fleabane	Erigeron repens
Eriogonum	Eriogonum
Fendler groundsel	Senecio fendleri
Fendler sandwort	Arenaria fendleri
Fremont geranium	Geranium fremonti
Geranium	Geranium
Gland cinquefoil	Potentilla glandulosa
Goldenweed	Aplopappus
Groundsel	Senecio
Hairy goldaster	Chrysopsis villosa
Hoarhound	Marrubium
Horseweed fleabane	Erigeron canadensis
Iris	Iris
Lambert crazyweed	Oxytropis lamberti
Lewis flax	Linum lewisi
Lupine	Lupinus
Marshmarigold	Caltha
Milkvetch	Astragalus
Mountain goldenpea	Thermopsis montana
Nickleaf milkvetch	Astragalus goniatus
Pedicularis	Pedicularis
Penstemon	Penstemon
Prairie sunflower	Helianthus petiolaris
Prostrate knotweed	Polygonum aviculare
Pussytoes	Antennaria
Rock goldenrod	Solidago petradoria
Rocky Mountain pussytoes	Antennaria aprica
Rose pussytoes	Antennaria rosea
Rush skeletonplant	Lygodesmia juncea
Russian thistle	Salsola kali tenuifolia
Saskatchewan cinquefoil	Potentilla effusa
Showy goldeneye	Viguiera multiflora
Silver cinquefoil	Potentilla argentea
Silvery lupine	Lupinus argenteus
Slimstem cinquefoil	Potentilla filipes
Stickseed	Lappula
Trailing fleabane	Erigeron flagellaris

Common and Scientific Names

Common name	Scientific name
Western yarrow	Achillea lanulosa
White clover	Trifolium repens
Yellow owlclover	Orthocarpus luteus

Browse

Alder	Alnus
Arkansas rose	Rosa arkansana
Bearberry, "kinnikinnick"	Arctostaphylos uva-ursi
Big sagebrush	Artemisia tridentata
Bitterbrush	Purshia tridentata
Bog birch	Betula glandulosa
Broom snakeweed	Gutierrezia sarothrae
Bush cinquefoil	Potentilla fruticosa
Bush rockspirea	Holodiscus dumosus
Ceanothus	Ceanothus
Chokecherry	Prunus
Cottonthorn horsebrush	Tetradymia spinosa
Currant, gooseberry	Ribes
Dogwood	Cornus
Fringed sagebrush	Artemisia frigida
"Kinnikinnick"	Arctostaphylos uva-ursi
Mammilaria	Mammilaria
Manzanita	Arctostaphylos
Mountain mahogany	Cerococarpus montanus
Oak	Quercus
Pingue	Actinea richardsoni
Rabbitbrush	Chrysothamnus
Rose	Rosa
Serviceberry	Amelanchier
Small soapweed	Yucca glauca
Water birch	Betula fontinalis
Wax currant	Ribes cereum
Willow	Salix
Wrights sagebrush	Artemisia wrighti

Trees

Alder	Alnus
Aspen	Populus tremuloides
Cottonwood	Populus
Douglas fir	Pseudotsuga taxifolia
Juniper	Juniperus
Lodgepole pine	Pinus contorta latifolia
Maple	Acer
Pinon	Pinus edulis, P. monophylla
Ponderosa pine	Pinus ponderosa